Discrete Structures and Graph Theory

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| Teaching Scheme  Lectures: 2 Hrs / Week  Tutorials: 1 hr / week | Examination Scheme:  Assignment/Quizzes : 40 marks  End Semester Exam : 60 marks |

Course Outcomes

Students will be able to:

1. Explain formal logic and different proof techniques.
2. Recognize relation between different entities using sets, functions, and relations.
3. Use Chinese Remainder Theorem & the Euclidean algorithm for modular arithmetic.
4. Solve problems based on graphs, trees and related algorithms.
5. Relate, interpret and apply the concepts to various areas of computer science.

Course Contents

Set Theory, Logic and Proofs **:** Propositions, Conditional Propositions, Logical Connectivity, Propositional calculus, predicates and Quantifiers, First order logic, Proofs: Proof Techniques, Mathematical Induction, Set, Combination of sets, Finite and Infinite sets, countable and Uncountable sets, Principle of inclusion and exclusion,

[8 Hrs]

Relations, Functions, Recurrence Relations: Definitions, Properties of Binary Relations, Equivalence Relations and partitions, Partial ordering relations and lattices, Chains and Anti chains. Theorem on chain, Warshall's Algorithm & transitive closure, Recurrence relations. Functions: Definition, Domain, Range, Image, etc. Types of functions: Surjection, Injection, Bijection, Inverse, Identity, Composition of Functions, Generating Function

[8 Hrs]

Number Theory: Basics of Modulo Arithmetic, Basic Prime Number Theory, GCD, LCM, Divisibility, Euclid's algorithm, Factorization, Congruences, inverse , multiplicative inverse, Chinese Remainder Theorem

[4 Hrs]

Counting: Basic Counting Techniques (sum, product, subtraction, division, exponent), Pigeonhole and Generalized Pigeonhole Principle with many examples, Permutations and Combinations and numerical problems, Binomial Coefficients Pascal's, Identity and Triangle

[6 Hrs]

Graphs & Trees: Basic terminology, multi graphs and weighted graphs, paths and circuits, shortest path Problems, Euler and Hamiltonian paths and circuits, factors of a graph, planar graph and Kuratowskis graph and theorem, independent sets, connectivity graph coloring. Trees, rooted trees, path length in rooted trees, binary search trees, spanning trees and, theorems on spanning trees, cut sets , circuits, minimum spanning trees, Kruskal’s and Prim’s algorithms for minimum spanning tree.

[8 Hrs]

Algebraic Systems: Algebraic Systems, Groups, Semi Groups, Monoids, Subgroups, Permutation Groups, Codes and Group codes, Isomorphism and Automorphisms, Homomorphism and Normal Subgroups, Ring, Field.

[6 Hrs]

Text Books

“Discrete Mathematics and Its Applications”, Kenneth H. Rosen, 7th Edition, Tata McGraw-Hill, 2017, ISBN: 9780073383095.

“Elements of Discrete Mathematics”, C. L. LIU, 4th Edition, Tata McGraw-Hill, 2017, ISBN-10: 1259006395 ISBN-13: 978125 9006395.

Reference Books:

”Discrete Mathematical Structures”, G. Shanker Rao, 2nd Edition2009, New Age International, ISBN-10: 8122426697, ISBN-13: 9788122426694

“Discrete Mathematics”, Lipschutz, Lipson, 2nd Edition, 1999, Tata McGraw-Hill, ISBN: 007 463710X.

“Graph Theory”, V. K. Balakrishnan, 1st Edition, 2004, Tata McGraw-Hill , ISBN-10: 0-07-058718-3, ISBN-13: 9780070587182.

“Discrete Mathematical Structures”, B. Kolman, R. Busby and S. Ross, 4th Edition, Pearson Education, 2002, ISBN: 8178085569

“Discrete Mathematical Structures with application to Computer Science”, J. Tremblay, R. Manohar, Tata McGraw-Hill, 2002, ISBN: 0070651426

”Discrete Mathematics”, R. K. Bisht, H. S. Dhami, Oxford University Press, ISBN: 9780199452798

**Modules / Lectures**

* [Week 1](https://nptel.ac.in/courses/106/106/106106183/)
  + [Motivation for Counting](https://nptel.ac.in/courses/106/106/106106183/)
  + [Paper Folding Example](https://nptel.ac.in/courses/106/106/106106183/)
  + [Rubik's Cube Example](https://nptel.ac.in/courses/106/106/106106183/)
  + [Factorial Example](https://nptel.ac.in/courses/106/106/106106183/)
  + [Counting in Computer Science](https://nptel.ac.in/courses/106/106/106106183/)
  + [Motivation for Catalan numbers](https://nptel.ac.in/courses/106/106/106106183/)
  + [Rule of Sum and Rule of Product](https://nptel.ac.in/courses/106/106/106106183/)
  + [Problems on Rule of Sum and Rule of Product](https://nptel.ac.in/courses/106/106/106106183/)
  + [Factorial Explained](https://nptel.ac.in/courses/106/106/106106183/)
  + [Proof of n! - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
  + [Proof of n! - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
  + [Astronomical Numbers](https://nptel.ac.in/courses/106/106/106106183/)
  + [Permutations - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
  + [Permutations - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
  + [Permutations - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
  + [Permutations - Part 4](https://nptel.ac.in/courses/106/106/106106183/)
  + [Problems on Permutations](https://nptel.ac.in/courses/106/106/106106183/)
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  + [Combinations - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
  + [Combinations - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
  + [Combinations - Part 4](https://nptel.ac.in/courses/106/106/106106183/)
  + [Problems on Combinations](https://nptel.ac.in/courses/106/106/106106183/)
  + [Difference between Permuations and Combinations](https://nptel.ac.in/courses/106/106/106106183/)
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  + [Combination with Repetition - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
  + [Combination with Repetition - Problems](https://nptel.ac.in/courses/106/106/106106183/)
  + [Binomial theorem](https://nptel.ac.in/courses/106/106/106106183/)
  + [Applications of Binomial theorem](https://nptel.ac.in/courses/106/106/106106183/)
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  + [Multinomial theorem](https://nptel.ac.in/courses/106/106/106106183/)
  + [Problems on Binomial theorem](https://nptel.ac.in/courses/106/106/106106183/)
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  + [Catalan Numbers - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
  + [Catalan Numbers - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
  + [Catalan Numbers - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
  + [Catalan Numbers - Part 4](https://nptel.ac.in/courses/106/106/106106183/)
  + [Examples of Catalan numbers](https://nptel.ac.in/courses/106/106/106106183/)
  + [Chapter Summary](https://nptel.ac.in/courses/106/106/106106183/)
* [Introduction to Set Theory](https://nptel.ac.in/courses/106/106/106106183/)
* [Example, definiton and notation](https://nptel.ac.in/courses/106/106/106106183/)
* [Sets - Problems Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Subsets - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Subsets - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Subsets - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [Union and intersections of sets](https://nptel.ac.in/courses/106/106/106106183/)
* [Union and intersections of sets - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Union and intersections of sets - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Union and intersections of sets - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [Cardinality of Union of two sets - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Cardinality of Union of sets - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Cardinality of Union of three sets](https://nptel.ac.in/courses/106/106/106106183/)
* [Power Set - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Power set - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Power set - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [Connection betwenn Binomial Theorem and Power Sets](https://nptel.ac.in/courses/106/106/106106183/)
* [Power set - Problems](https://nptel.ac.in/courses/106/106/106106183/)
* [Complement of a set](https://nptel.ac.in/courses/106/106/106106183/)
* [De Morgan's Laws - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [De Morgan's Laws - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [A proof technique](https://nptel.ac.in/courses/106/106/106106183/)
* [De Morgan's Laws - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [De Morgan's Laws - Part 4](https://nptel.ac.in/courses/106/106/106106183/)
* [Set difference - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Set difference - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Symmetric difference](https://nptel.ac.in/courses/106/106/106106183/)
* [History](https://nptel.ac.in/courses/106/106/106106183/)
* [Summary](https://nptel.ac.in/courses/106/106/106106183/)
* [Motivational example](https://nptel.ac.in/courses/106/106/106106183/)
* [Introduction to Statements](https://nptel.ac.in/courses/106/106/106106183/)
* [Examples and Non-examples of Statements](https://nptel.ac.in/courses/106/106/106106183/)
* [Introduction to Negation](https://nptel.ac.in/courses/106/106/106106183/)
* [Negation - Explanation](https://nptel.ac.in/courses/106/106/106106183/)
* [Negation - Truthtable](https://nptel.ac.in/courses/106/106/106106183/)
* [Examples for Negation](https://nptel.ac.in/courses/106/106/106106183/)
* [Motivation for OR operator](https://nptel.ac.in/courses/106/106/106106183/)
* [Introduction to OR operator](https://nptel.ac.in/courses/106/106/106106183/)
* [Truthtable for OR operator](https://nptel.ac.in/courses/106/106/106106183/)
* [OR operator for 3 Variables](https://nptel.ac.in/courses/106/106/106106183/)
* [Truthtable for AND operator](https://nptel.ac.in/courses/106/106/106106183/)
* [AND operator for 3 Variables](https://nptel.ac.in/courses/106/106/106106183/)
* [Primitive and Compound statements - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Primitive and Compound statements - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Problems involoving NOT, OR and AND operators](https://nptel.ac.in/courses/106/106/106106183/)
* [Introduction to implication](https://nptel.ac.in/courses/106/106/106106183/)
* [Examples and Non-examples of Implication - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Examples and Non-examples of Implication - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Explanation of Implication](https://nptel.ac.in/courses/106/106/106106183/)
* [Introduction to Double Implication](https://nptel.ac.in/courses/106/106/106106183/)
* [Explanation of Double Implication](https://nptel.ac.in/courses/106/106/106106183/)
* [Converse, Inverse and Contrapositive](https://nptel.ac.in/courses/106/106/106106183/)
* [XOR operator - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [XOR operator - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [XOR operator - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [Problems](https://nptel.ac.in/courses/106/106/106106183/)
* [Tautology, Contradiction - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Tautology, Contradiction - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Tautology, Contradiction - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [SAT Problem - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [SAT Problem - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Logical Equivalence - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Logical Equivalence - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Logical Equivalence - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [Logical Equivalence - Part 4](https://nptel.ac.in/courses/106/106/106106183/)
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* [Double negation - Part 1](https://nptel.ac.in/courses/106/106/106106183/)
* [Double negation - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
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* [De Morgan's Law - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
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* [Rules of Inferences - Part 2](https://nptel.ac.in/courses/106/106/106106183/)
* [Rules of Inferences - Part 3](https://nptel.ac.in/courses/106/106/106106183/)
* [Rules of Inferences - Part 4](https://nptel.ac.in/courses/106/106/106106183/)
* [Rules of Inferences - Part 5](https://nptel.ac.in/courses/106/106/106106183/)
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